109 Getting a Hold on Design

Humans not only design technological tools; they also provide the model or inspiration for many tools. For instance, robotic arms are useful not only to replace human arms, but also to work with hazardous materials or in remote environments—such as handling radioactive materials or gathering samples from the ocean depths or from other planets. Brain and heart surgeons use small robotic arms for very delicate operations, and these arms generally require computer technology. Surgeons also use robotic arms in new "keyhole" techniques, in which small incisions are used for major operations, including heart surgery. You can probably think of many other everyday uses.

CHALLENGE **How can you make a mechanical arm that moves a mass back and forth?**

MATERIALS

For each group of four students

- **1 ball of string**
- **2 pairs of scissors**
- **1 70-g mass**
- **straws, plastic tubes, tape, paper clips**
- **1 Student Sheet 108.1, "Guide for Robotic Arm"**

This model shows the mechanical arm of the Mars Viking lander collecting soil samples.

Developing a Mechanical Arm

You are a mechanical engineer, and today you face an unusual task. Your supervisor, Dr. Garcia, has been given the task of developing a mechanical arm for handling dangerous substances. He has to attend a conference and assigns the development of a prototype to you. He tells you that the arm must be able to move an object with a mass of about 70 grams 6 cm in two opposite directions. You can use only one of your hands to operate the controls. You must use your other hand to hold the mechanical arm in place.

PROCEDURE

1. As a group, carefully read "Developing a Mechanical Arm" (above). Determine what the design requirements are, and make a list of them in your science notebook.
2. In your group, discuss and record your ideas about how you will construct your prototypes.
3. In your science notebook, create a data table on which you can record your observations and collect your data.
4. As a group, build and test your first prototype(s). (Your group may wish to make more than one at a time.) Remember that you may move only one of your hands to control the mechanical arm. The other hand and arm must be still and hold the mechanical arm in a fixed position. Record your observations and test results in your data table.
5. Discuss your results with your group. Decide which features of your prototype(s) were helpful and which were not. Record ideas for improving your best prototype. If possible, focus on testing the effect of one variable.
6. Make and test one or more improved prototypes. Record your results in your data table.
7. Present your best prototype to the class: demonstrate its function and describe your design process.

ANALYSIS

1. In what real-world applications could robotic arms be useful? Include everyday as well as high-tech examples.

2. What are some of the trade-offs of inventing as a group compared to working individually?

3. Thomas Edison invented over 1,000 inventions, including the movie camera, the telegraph, and the phonograph (record player). He once said, "It is what you do after failure that counts." What did he mean? Explain your answer with an example from your work during this unit.

4. Isaac Newton is thought to have said, "If I have seen a little farther than others, it is because I have stood on the shoulders of giants." What did he mean? Explain your answer with a real example of an invention or scientific discovery.

5. **Reflection:** Describe the relationship between science and technology.